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Abstract

Difference it becomes relieved only by looking for the secondary of the complicated driving operation is provided to operator the composite picture driving. Image having right and left 180 drawing viewing direction of the back

of vehicle the image-pickup pictures is used of the camera installed at the vehicles are inverted and it indicates. And the propel trace (41) is together indicated in the moving back of self-car (a). Moreover, the domain (43) of the distant place is enlarged. It indicates in the subwindow (44), or supporting lines (45, 46, 47) showing distance from the vehicles are together indicated (c) or the place does.



Representative Drawing(s)

Fig. 5



Keyword(s)

The propel trace, and subwindow.



Description

■ Brief Explanation of the Drawing(s)

Figure 1 is a block diagram showing the configuration of the monitor system about each embodiment of the present invention.

Figure 2 is a drawing showing an example of the camera geometry.

Figure 3 is a drawing showing the example of each camera image-pickup pictures shown in fig. 2.

Figure 4 is an example of the situation in which the first preferred embodiment is suitable of the invention. The drawing which turns the steering while backing the vehicles up and shows the case of inducing to the road.

Figure 5 is an example of the screen type about the first preferred embodiment of the invention.

The image generation drawing making use of the fig. 6 silver cylinder model.

Figure 7 is an image generation drawing using the bowl model.

Figure 8 is an example of the screen type about the second preferred embodiment of the invention.

Figure 9 is an example of the screen type about the third preferred embodiment of the invention.

Figure 10 is an example of the screen type about the third preferred embodiment of the invention.

Figure 11 is an example of the image about the fourth preferred embodiment of the invention.

Figure 12 is a drawing illustrating the condition that the object of the boundary neighborhood is destroyed through the virtual visual point image.

Figure 13 is an example of the screen type about the fifth preferred embodiment of the invention.

Figure 14 is an example of the screen type about the sixth preferred embodiment of the invention.

Figure 15 is an example of the screen mode switch about the sixth preferred embodiment of the invention.

Figure 16 is a block diagram showing the system configuration enabling the screen mode switch shown in fig. 15.

Figure 17 is a drawing illustrating the fourth subject of the present invention.

Figure 18 is a drawing illustrating the fifth subject of the present invention.

Figure 19 is an other example of the screen type about the second preferred embodiment of the invention.

Figure 20 is an other example of the screen type about the third preferred embodiment of the invention.

Figure 21 is a screen type about the third preferred embodiment, and, the other example of the invention.

※ Details of the Invention

※ Background Art

It is the apparatus for watching convention, and the surrounding area of vehicle by using camera. Camera is set up in after trunk portion of the vehicles etc. to rearward. The system providing the image obtained in this camera to operator is known. Therefore, operator can know the back of vehicle situation without the things looking into a mirror. And recently, the system (it has this as ' method of hitherto 1') which together presents the mobile track of tire to the camera image is known it is still simple, the camera image is presented. Therefore, the advance of the vehicles is predictable with getting a grip on the back of vehicle situation.

However, in the method of hitherto 1, the back of vehicle situation can be known. However, it cannot help depending on visual and mirror about the part of the except. The literature it is the system the for informing easily operator system knows the position relation of the surrounding whole and self-car this 1: it has the apparatus etc in the task Patent Publication No. 11-78692 A gazette. Disclosed are the mode (it has this as ' method of hitherto 2') it sets up the camera for the video for vehicle offer of the multiple unit (8 part) in this literature 1 in the surrounding area of vehicle, and it synthesizes the image (it hereinafter says to be ' subimage ' this) transforming the image taken a picture with each camera, and that it obtains the new image looking around the magnetism surrounding area of vehicle at a time. Particularly, the photographed images of the plurality camera is provided to operator the image easy to general, grasp the position relation of self-car and surrounding object the subimage among, and the continuity of the adjacent boundary are maintained it arranges it transforms.

But as to the different driving condition, in case of presenting operator the image synthesized with the above-described method of hitherto the problem as follows is generated.

1. The problem of the method of hitherto 1 and the subject to solve.

In the method of hitherto 1, it does not light to not within the invention in which the camera image is limited than the vehicles back-end among rear. Therefore, the front part, for example, the degree of contact between the self-car laterality and the surrounding object cannot determine as the door mirror than the self-car back-end. Therefore, in order that the degree of contact and backward condition both sides of the part were perceived,

the parallel use of the door mirror and display image was forced operator to do and the burden of operator was great.

And the method of hitherto 1 indicates the situation of the limited viewing direction of the back of vehicle. Therefore, in using in the driving condition which need to know the wide range situation, it is unable to be appropriate. For example, as shown in Figure 4, in case going back, the steering is turned and the vehicles is induced to the road, the image which materially includes the posterior view of figure 180 in order to back confirm the access vehicles from right and left need to be presented operator. Because the viewing direction becomes narrow, it cannot use the image presented in the method of hitherto 1 in this kind of use at all.

Therefore, difference the first subject to solve becomes relieved only by looking as to the case like fig. 4 is provided to operator the composite picture driving.

2. The problem of the method of hitherto 2 and the subject to solve.

· first problem: display range.

In the method of hitherto 2, in order that it easily presents to know the position relation of the self-car close staff surrounding, image is presented, the surrounding corp. sulfur is just looked down in self-car it discloses. But the self-car neighborhood and the except part both nothing was not disclosed about the way of presentation of the image canning at the same time be grasped. Therefore, in the next example (a), and the driving condition like (b), the composite picture according to the method of hitherto 2 is presented, it is sufficient in the operation support.

(a) The access including roadside etc.

When the access including roadside etc. is carried out, the following 2 branching point is required about the image showing to operator. That is, when like that going ahead with the point whether the approach condition to roadside was about a or going back, whether or not, and the corresponding vehicle came at the progress direction front whether it had for example, obstacle including the electric pole or validator etc., whether when they presence was confirmed in other words, it is the point of whether or not whether it can not contact and it avoid.

But in the viewing image, the seen range is curbed. Therefore, it requires the image which lights only the close staff surrounding specifically if it tries to look at the approach condition to roadside. The image showing the progress direction front for example in the number M until the several tens M front at least becomes necessary. The demand of both sides cannot be satisfied by a case or one image.

Therefore, the composite picture which at the same time, the second subject to solve can know the situation of the advance or the progress direction front when going back as to the case like the access including roadside etc. is not access to the roadside of self-car is provided to operator.

(b) The park including the steering wheel direction manipulation.

In case this viewing image is presented as to the park time, it need the confirmation of the backward condition in case of blandly going back in the first step of the parking operation. But in the viewing image, the range shown is curbed. Therefore, the burden of operator is enlarged by can not help use mirror for the recognizing backward direction in the moving back. And in case of making the handle operation (the manipulation inducing difference to the object location with the minute movement of the either before or after) frequent when residing, the front confirmation of being not recognizing backward direction becomes necessary.

Therefore, the third subject to solve is the handle operation is provided to operator not only the ambient condition as to the park, included but also the composite picture which at the same time, the front situation of the progressive direction can know when going ahead or going back.

- second problem: the disappearance of object.

In boundary, in order that it changes image so that the road part be continued at least, it is the problem that 3-dimensional material transformed into according to the deformation is deleted for the layout of subimage.

(a) of fig. 17 shows the bar (P1) erected at corner after the right of the vehicles. This bar (P1) is photographed in the camera (2) and the camera (3) both sides shown in fig. 2 and as it below increases based on the earth point of the bar (P1), lower-part, and the bar (P1A) of the camera (2) photographed images are distorted by the image transformation. In the meantime, the bar (P1B) of the camera (3) photographed images is distorted by the image transformation as it increases based on the bar (P1) earth point in a clockwise direction. But each bar (P1A, P1B) increases to the domain which is not altogether used as subimage. Therefore, the part increasing is deleted and the part does not remain about the part in which consequently the bar (P1) contacts with the surface on the composite picture ((b) of the drawing 17), it becomes difficult that the bar existing in fact is acknowledged in the composite picture. It is the reason in which this causes the problem of the object disappearance.

Therefore, the problem that the fourth subject to solve describes in detail is provided to operator the composite picture in which general, at the same time, distance between the position relation and the surrounding object can be grasped with self-car and surrounding object it avoids.

- third problem: the discontinuity of boundary.

In the method of hitherto 2, each camera image deformation is performed in order to maintain continuity in the boundary of the adjacent subimage. However, it principals, it is difficult to maintain continuity in all parts of boundary. Therefore, in the mode looked, it discloses to transform so that the continuity at the road surface part be maintained so that the road surface part be perceived without the sense of incongruity at least. But for this reason, object except the road is distorted as it increases. The trouble that object except the road in which this is positioned in the boundary of subimage consists of discontinuity in this boundary is caused. For example, in fig. 18, the vehicles which the park middle positioned at the boundary of the subimage which transforms the image of the camera (3) and camera (2) and obtained is becomes this boundary to boundary to discontinuity and the old times when it becomes the consequently indistinct image is indicated. Therefore, in this kind of the indistinct image, distance with the surrounding object is not grasped. Therefore the task which in conclusion, looks mirror etc. at operator and confirms this is required and burden is enlarged.

Therefore, the fifth subject, to solve is problem is provided to operator the composite picture of the equation avoiding and certainly includes the necessary information in the camera image in the safe driving at least.

And if the discontinuity problem at boundary is considered with subimage, the edge giving boundary to the where of the composite picture in the various driving condition relates to the utility of the composite picture. Generally, as to many part of the complicated driving operation, for example, park (column, and parallel) or the approach light, inventors learned as to the place, where operator wanted to know the detail situation through the experiment performed against about testee 10 persons rather to concentrate on direction of left and right side 180 drawing domain than forward and backward of car.

Therefore, it is considered to be the sixth subject that direction of left and right side of the vehicles more consecutively present the composite picture as as possible. However, it is not disclosed in the method of hitherto 2 about the solution about such subject.

※ The Technical Challenges of the Invention

The invention relates to the image processing technology which produces the composite picture by using the image-pickup pictures of the plurality camera which installs in the vehicles. And it belongs to the technology which is effective in the monitor system used to especially, the safety confirmation auxiliary light in the vehicle drive.

■ Example(s)

Hereinafter, referring to the figure, it decides to illustrate for the embodiment of the present invention. Firstly, in order to realize each embodiment, it illustrates for the necessary whole configuration of the monitor system about the invention. Specifically it illustrates for all kinds of the display screens the shape example about the invention.

Figure 1 is a block diagram showing the monitor system configuration about the invention. As to the monitor system shown in fig. 1, the image processor (20) has an plurality of camera images outputted from the camera (11) as input. These are synthesized into the deformation / and the new image is produced. This composite picture is indicated by the display device (30). The image processor about the invention is comprised of the image processor (20).

And in the present specification, the image which is generated by synthesizing into the deformation /, includes one camera image which is not image generated from a plurality of camera images and 'composite picture'.

The display device (30) of the present invention is the liquid crystal display but it typically can use the other display device including the plasma display etc. And the display of the present invention is good although it publicly uses with the on-vehicle type GPS terminal display (what is called, the car navigation system display). And it prepares independently of this.

It is the color having the charge coupled device (10), typically, the solid imaging device including CCD, the CMOS device etc or the monochrome digital camera. And it is comprised of the photographic means, for example, the lens, and the combination of prism or mirror. And it is comprised lens, and the incident light to prism or mirror is delivered to image pickup device having in the location. The incident light to prism or mirror is delivered to image pickup device having in the location is apart from the photographic means after the predetermined optical path.

Figure 2 is an example of the image-pickup pictures of each camera shown example, and fig. 3 for fig. 2 of the camera geometry. In fig. 2, WL1~WL5 the white line, and P1~P4 are bar. In the example of fig. 2, the case of using the camera tub of 2 part with the front greel, left and right door mirror, and the sum 4 place 8 part of after trunk is shown. The camera geometry shown in fig. 2 cannot secure the viewing direction of figure 180 with the thing for obtaining the image of back and pro 4 side respective Figure 180 the viewing direction of difference with the current camera with 1. Therefore, it decides on the camera of for convenience 2 part to the assembly and it materially obtains figure 180 the viewing direction.

The image processor (20) synthesizes the camera image (the case of deciding on the camera of the assembly to 1 part is the camera image of 4 each) like showing in fig. 3 of 8 each with the deformation /. The composite picture which is the same looked down from for example, the vehicles upside to the vertical downward is produced. For the composite picture production, the composite process (inclusion the processing (hereinafter, the boundary treatment) including the boundary softening etc) of the subimage cutting the necessary part of the image transformation processing or the transformed image becomes necessary. The mapping table (Mapping table) reference part (21) is included in the configuration of fig. 1. The mapping table (MPT) is used in order to perform the image-pickup pictures processing in one process.

The image processor (20) inputs the image-pickup pictures from the camera (1~N). These image-pickup pictures are processed. The processing of the complementary rare book is the composite process (boundary

treatment inclusion) of the subimage cut down with ① image transformation shredding process, and ②. The processing of these ① and ②'s separately practices. And a part is performed to 1 the process in other words. In fig. 1, it is done by the configuration which includes the mapping table in order to perform the photographed images processing in 1 the process.

'mapping table' refers to the table in which the correspondence of pixel data of the pixel of the composite picture and each camera image are described. And the table is used in order to perform the generating process of the composite picture at high speed. This kind of the mapping table is prepared in calculation or manually etc. in advance. In that way uses the geometric transformation etc. the desired composite picture can be produced at high speed. And the display mode can be switched by replacing the mapping table.

Specifically the mapping table is stored in the ROM (inclusion ROM which the inscribe / including EEPROM etc. is delible) or RAM for example. Since for example, the processor within the image processor writes mapping data found due to calculation in ROM or RAM the storage of the mapping table realizes. And by using data transmitter including the communications line or the disk drive etc., mapping table data provided as the firmware is written in RAM or ROM.

Next, it particularly decides to illustrate for all kinds of the display screens the shape example about the invention.

(the first preferred embodiment)

As shown in Figure 4, in case going back, it turns the steering and the first preferred embodiment induces the vehicles to the road one form of the invention which is comprised of order to solve the above-described first subject for example, the vehicles is used in order to back confirm the access vehicles from right and left.

Next, it illustrates for the example of the display screen form.

(a) of fig. 5 shows an example in which an example of the screen type about this embodiment for using only in confirmation, image having right and left 180 drawing viewing direction of the back of vehicle specifically the camera (3) shown in fig. 2 and the image taken a picture with the camera (7) are used are inverted and it indicates. The propel trace (41) is together indicated in this in the moving back of the magnetism difference (the synthetic origin oneself photographed images is the Figures are omitted). As shown in it can know at (a) of fig. 5, that is, right and left 180 drawing can be till the end looked at in the nearly faced situation about the road in which the vehicles backend is perpendicularly put to the vehicles in one end of the road with other side. Therefore, operator sits the display of the vehicles (42) approaching from the left side down at the driver's seat and operator can grasp this image as bomb for example.

(b) of fig. 5 is the other one example of the screen type about this embodiment. It is better that using the reason of the etc. in which the resolution of camera or screen isoform is low, in case of being difficult to just know distance to the vehicles coming on from the distant place it uses. Specifically, the domain (the dotted line rectangle area (43)) of the distant place is enlarged. It indicates in the separate place among screen as the subwindow (the solid line rectangle area (44)). Therefore, in the whole image, place and the distant neighborhood can be grasped at a time. And it is confirmable with the and distant state of the place by subwindow. It is better that in order to prevent since being attached on the whole image from operation therefore blotting out the important information with this as long as it is possible, subwindow predetermines the appendix place.

(c) of fig. 5 is the other one example of the screen type about this embodiment. When isoform just well cannot know distance to the vehicles approaching from the distant place, the supporting line showing distance is overlapped on image and the vehicles indicates. Therefore, the access vehicles, approximately, distance just can be known. In (c) of fig. 5, about 2m, and the location of about 10m and about 5m are from side to side indicated with the solid line (45), and the small dotted line (46) and the thick dotted line (47) in the respective self-car.

Next, the method for preparing the image having this kind of Figure 180 the viewing direction is simply illustrated.

The fig. 6 silver pair camera image is projected on the cylinder model. The projection image is like that listed in the end in the rectangular grate surface. The method for obtaining the panorama image of the viewing direction 180 drawing is shown. In this method, the vertical width corresponds to the angle of the camera view range. Therefore, the image of the same magnification is obtained through any kind of direction of camera.

And figure 7 shows the method for obtaining the viewing direction 180 drawing burn as model except cylinder by using the model of the bowl form. It is the same with the fig. 6 to project the camera image on model. However, it is different to set up the virtual viewpoint looking at the projection image and prepare image with the clairvoyance reflection conversion. In this model, the bowl form is transformed or the location of the virtual viewpoint is moved. In that way the image enlarging the gad rearward of the magnetism difference and reduces the circumferential direction is prepared, or it is possible to prepare the image which reversely reduces the gad rearward of the magnetism difference and enlarges the circumferential direction.

Here, in the present preferred embodiment, the old times indicating the rearward 180 drawing viewing direction is indicated. However, with materially having the viewing direction to that with figure about 180 there is no practical problem. There is no need to set up camera in order to certainly include figure 180. And the viewing angle smaller than that is no problem. And it is natural to feel. However, even if it cuts and it indicates, it has no connection with the rearward safety confirmation in which the sky is spotted including the part etc. about the unnecessary part.

(the second preferred embodiment)

The second subject which the second preferred embodiment describes in detail is provided to operator the composite picture which can be one form of the invention, which is comprised of order to solve for example, the case like the access including roadside etc., and which at the same time, the front state of the progressive direction can know in not only the roadside approach condition of the magnetism difference but also the advance or the lagging behind.

Next, it illustrates for the example of the display screen form.

(a) of fig. 8, and (b) shows the screen type about this embodiment which it prepares by using 4 the camera of cameras (1, 2, 5, 6) shown in fig. 2 (the synthetic origin oneself photographed images is the Figures are omitted). The right image of self-car and, the left image uses the camera (1) and camera (2) the video of the camera (6) and camera (5) and the video is prepared. As to each composite picture, it is synthesized relatively so that enlargement and reduction ratio of the vehicles close staff part including be the ground of tire enhanced than enlargement and reduction ratio of the vehicle periphery part. And in the vehicles close staff part, enlargement and reduction ratio become smaller as it becomes estranged to the vehicle periphery part.

The example of this kind of image synthesis method is simply illustrated. Effective one of the method for simply preparing this kind of compose is the method for synthesizing by using model like the compose of the first preferred embodiment. For example, if the bowl model shown in fig. 7 is used, it does like next and (a) left image of fig. 8 can synthesize.

1. In order that the floor of the bowl model contacts for the vehicles camera (5) and camera (6) on the road of location, the bowl model is prepared. At this time, the vehicles the size of the bowl model is done by the size of the extent which it completely surrounds with the bowl inner surface.

2. The camera (5) and the image taken a picture with the camera (6) are projected to the respective bowl inner surface.

3. In location between the camera (5) and the camera (6) the virtual viewpoint, it sets up in the upside (for example, 4m) in the down direction. The video of the camera (6) and the camera (5) projected onto bowl in the processing of 2 is looked at in the virtual viewpoint.

The image which is synthesized relatively so that enlargement and reduction ratio of the vehicles close staff part including be the tire ground enhanced than enlargement and reduction ratio of the vehicle periphery part like showing with the processing of these 3 steps for (a) left of fig. 8 can be obtained.

Here, as the model side (the bowl inner surface in this example) in which the circumferential part is reduced if it why uses the bowl-shaped model, it projects lower-part, and the camera image draws to the direction (the perpendicular fall direction in this example) of the virtual viewpoint to parallel.

The advantage of being loud of mode can give the point that it freely can determine enlargement and reduction ratio of the vehicle periphery part about enlargement and reduction ratio of the vehicles close staff part by changing the bowl model or doing. For example, when the bowl model is circular, the image which is reduced according to become estranged regardless of direction in bottom is obtained in the bowl bottom surface centering around the suitable part. And it like that puts and as to the bottom surface, only form the bowl model to ellipse. If the axis direction of this ellipse coincides with the vehicle side, it makes smaller than about reduction of the vehicles lateral direction in the bowl bottom surface around the suitable part about the reduction of the vehicle progress direction part. Of course, opposite is possible.

And here, it explains the method for synthesizing by using the image which is synthesized relatively so that enlargement and reduction ratio of the vehicles close staff part including be the ground of tire enhanced than enlargement and reduction ratio of the vehicle periphery part and using the bowl model. However, it is of course that the synthesis using method except the bowl model is possible.

And the virtual viewpoint is set up as the camera, nearly, the upward lower direction while camera is installed in the car body. Image is synthesized by using the bowl model. That is, the reduction deformation as described above is performed around the camera installation place. Still, linearity to the forward movement direction is there maintained with the linearity of one side of car body. By using the image which it synthesizes by setting up the virtual viewpoint as cameras (1, 2), nearly, the upward lower direction and using the bowl model, the image of (b) of fig. 8 is prepared.

Next, specifically the approach condition to the brook which uses (a) of fig. 8 and is in roadside is illustrated. In (a) of fig. 8, in order that it knows whether the slack to the brook which is in roadside in the passenger seat side of the vehicles is about a, the vehicles close staff part is enlarged. About 5cm maintains the resolution can find out against this close staff part at least. Furthermore, in order that it determines only by looking at whether self-car became back to some extent intimate to the side, in order to the magnetism tire of vehicle be seen it indicate (the solid line primitive area (51))s, this kind of image is presented with experiment. In that way the difficult to do about the access to roadside with 10cm this harrow operator can know that the operator easily approaches to 5cm within. That is, the big effect is confirmed that this display type has the effect on the access operation.

In the meantime, the interval slack with the corresponding vehicle for to passing through self-car and right side a extent approval can confirm as this display type (dotted line primitive area (52)), (b) of fig. 8 shows the situation example performing the same display type as (a) of fig. 8 this kind of confirmation. In this display type, the front maintains linearity untill and it is reduced. Therefore, the progressing line of the magnetism difference becomes line (the line (54) passing TYRE1 and TYRE3 and the line (53) passing TYRE2 and TYRE4) which get burnt because in order to contact to the either before or after tire. For this reason, in the right side front, in case the opposing difference comes on, the opposing difference is in the right than the right progressing line, whether the contact whether or not with the opposing difference can be easily determined as bomb otherwise the progressing line is spanned. Of course, screen is over the time reduced to the front. Therefore, the determination becomes possible in the situation coming on from the place where the opposing difference

is yet decreased with on-screen in advance. Therefore, self-car can be comfortably manipulated as operator. In the example of (b) of fig. 8, it can know to be ascertained than the right progressing line, the opposing leased house which is in the right, and the right side of self-car not be contacted and safely pass. Here, it was confirmed through experiment that the driving operation was easy if about 5m front the front state was seen at least.

However, thus even in case of being insufficient, it has the case of passing with the opposing difference in fact. That is, at the same time, also, the case where the case has object more protruded to outside than the car body including the door mirror etc. need confirmation by the time of operator with the screen confirmation.

And in fig. 8, with indicating the tire everything of 4 even if it shows on the composite picture only the partial tire, for example, the front tire, however it has no relation.

In the above, in the above, explain case, it uses the screen type of the second preferred embodiment the camera of 4 part as an example. Of course, the invention is not thus restricted, but it can perform even if it uses only the camera of 1 part. For example, in obstacle including the cost etc, although it is the case of setting up in the front side camera 1 large outside in the vehicle side of the passenger seat side, the image which is effective in the access to roadside is could offer to user with the invention.

Figure 19 is a drawing which when the screen type about this embodiment using only camera is compared with case, it uses the plurality camera, shows of 1 part. The example of the camera (RF, RR, LF, LR) camera image of 4 part installed at (a) among fig. 19 is left and right of car, and (b) are the composite picture prepared from the camera image shown for (a) of 4 like fig. 8. In this (c) is (a), it is the image synthesized to the camera image of the camera (LF). Here, as to (b) of fig. 19, and the self-car illust of (c), in order to make easy to know the magnetism difference location about the composite picture, it attaches. It certainly does not coincide with the self-car part included in image.

In the example of (c) of fig. 19, it 1 part is the camera used to compose. Therefore, the visual field range shedding light on image is restricted than the example of (b). But about 5cm maintains the resolution of the extent can recognize at least by enlarging the vehicles close staff part. Whether it to some extent has the time to the roadside brook or not knows at the vehicle side seat side. Furthermore, in order that it easily recognizes clearly only by looking at image whether the magnetism difference to some extent approached towards delivery, image is indicated in order to the tire of the magnetism difference show (the solid line primitive area).

Therefore, if the image like (c) is indicated, the opposing difference from the front is avoided in front of the narrow road on the passenger seat side roadside as to the driving environment like the case where the case has brook. Even in that case, it confirms whether tire comes off in the brook of roadside. And the access to roadside becomes possible while going ahead. Of course, in this case, the operator oneself need to confirm interval with the opposing difference but the burden of driving about the access is drastically reduced.

And the fisheye lens is used. In that way the wide visual field range can be enough obtained from the camera of 1 part. For example, the viewing angle sets up the camera in which 180 the fisheye lens of the either before or after is adhered in the passenger seat side lateral part of the vehicles. The invention using this camera image is realized. Therefore, the image of the opposite side lateral part and driver's seat can be indicated by the wide range. Therefore, it more safely drives.

(the third preferred embodiment)

The third subject which the third preferred embodiment describes in detail is provided to operator the composite picture of the equation which can be one form of the invention which is comprised of order to solve, and which at the same time, it can know the front state of the progressive direction as to the park of the equation accompanying for example, the handle rotation in not only the ambient condition but also the advance or the lagging behind.

Next, specifically it illustrates for the example of the display screen form in the pause of the vehicles in the advance and by using figs. 9 and 10 according to 3 kinds situation in the moving back (the synthetic origin oneself photographed images is the Figures are omitted).

1.The display type example in the car stop:

(a) of fig. 9 shows an example in which in the front of the self-car about the virtual visual point image, looked down from upside and the behind suitable part, the necessary image is attached in order to grasp the distant place in each direction. It Han NunE can know the front state of the direction which is not self-car neighboring and in which self-car moves. Therefore, it uses in the signal pause in case of etc. for the ambient condition confirmation of the immediately after and oscillation just before, or it in other words is applicable to the column parking, and the row parking.

2.The vehicles is the display type example among the slow forward:

(b) of fig. 9, and (c) show an example in which in the part which is considerable about the virtual visual point image which it altogether looks down from the upper part to the self-car front, the necessary image is attached in order to perceive the place which is far from the front. It Han NunE can know the front state of the progressive direction which is not self-car neighboring.

The other point of (b) of fig. 9 and (c) are the difference of the image for the grasp of the place which is far from the front. Firstly, boundary between image and the front image looked down (b) of fig. 9 are connected at the road surface part. Therefore, the forward barrier easily can know whether it is in a location of the self-car front. As the low speed driving time, it is effective in the access including not only in the time of oscillation but also the road driving or the toll booth etc. narrow. In the meantime, in the image which (c) of fig. 9 looks down, in order to fill up the part in which square is, it has the viewing direction of the front image as figure 180. It has the problem that the boundary of image does not continue. However, the problem has the advantage that it can look at the information of the broad with the width about the front viewing direction at a time. Particularly, it is suitable for the confirmation of the front 180 drawing surrounding of the oscillation former.

Here, in order that the domain of the self-car front widens as the advance rate increases about the virtual visual point image, even if the self-car location consecutively changes as the advance rate reversely goes down in order to come for the screen center, it has no relation. And the screen type is to the panorama image of after if the revolution per minute is exceeded.

3.The vehicles is the display type example among the moving back:

(a) of fig. 10, and (b) show an example in which in the part which is behind considerable about the virtual visual point image which it altogether looks down from the upper part with self-car, the necessary image is attached in order to perceive the place which is far from rearward. It Han NunE can know the front state of the backward direction which is not self-car neighboring.

(a) of fig. 10, and the other point of (b) are the difference of the image for grasping the place which is far from rearward. Firstly, (a) of fig. 10 the boundary of the front image and the image looking down continues in the road surface part. Since being connected at the road surface part, the forward barrier easily can know whether it is in a location of the self-car front or not. In boundary, it has the continuity of the road. In that way it is qualified to the image indicated in the column parking, and the initiation of the row parking. In the meantime, in order that (b) of fig. 10 fills up the part squared in the image looking down, it has the viewing direction of the rearward image as figure 180. It has the problem that the boundary of image does not continue. However, the problem has the advantage that square disappears about the back of vehicle in which the square section is many. Particularly, it is suitable for the confirmation of the rearward 180 drawing surrounding of the moving back former.

Here, in order that the self-car rear sphere widens as the reverse speed increases about the virtual visual point image, even if the location of self-car consecutively changes as the reverse speed reversely goes down in order to come to the screen center, it has no relation.

And the display type like showing in (a) of fig. 9 indicates in the case in which the vehicles does not move at all. In addition, when the advance and lagging behind including the handle rotation etc. are frequent, being repeated, it indicates. For example, if (a) of (b) of fig. 9 and fig. 10 are changed and it indicates in the handle rotation, even in case of being troublesome, it is in example. In such case, the absolute value of speed always indicates the image like showing period less than the designated value in (a) of fig. 9.

In the above, in the above, explain case, it uses the screen type of the third preferred embodiment the camera of 8 part as an example. Of course, the invention relates to for example, restriction including the cost etc. it is thus restricted. And using the invention it is the case that camera cannot set up in 2 part or 1 large outside in the vehicles center part of rear side, the effective image is could offer to user in the moving back.

Figure 20 is a drawing showing the screen type about this embodiment using the camera of 2 part. The example of the camera (BR, BL) camera image of 2 part installed at (a) among fig. 20 is the vehicle back side, and (b) are the drawing showing the virtual viewpoint location (in the upper part of the vehicles center part of end, it right looks down) when preparing the virtual visual point image, and the composite picture in which (c) uses the camera image shown for (a) of 2 and produced. In the composite picture of (c) of fig. 20, the virtual visual point image looked down from the upper part is beneath arranged. And in order to perceive the place which is far from and, rearward, the necessary image is arranged in the upper part.

When it uses only the camera of 2 part set up in the back of vehicle like this example, there is no number obtaining the image of the vehicles lateral part. However, the visual field range nearly can obtain the image of figure 180 about the back of vehicle. Therefore, it just Han NunE can know as image. For this reason, the composite picture which it produces by using the camera of this kind of 2 part as to the row parking or the column parking in the moving back is enough pragmatic.

Figure 21 is a drawing showing the screen type about this embodiment using the camera of 1 part. The camera image of 1 part installed at (a) among fig. 21 is the vehicle back side, and (b) is the drawing showing the virtual viewpoint location (it right looks down in the vehicles center part of end) when preparing the virtual visual point image, and the composite picture in which (c) uses the camera image shown for (a) and produced. In the composite picture of (c) of fig. 21, the virtual visual point image looked down from the upper part is beneath arranged. And in order to perceive the place which is far from and, rearward, the necessary image is arranged in the upper part.

In this example, camera is 1 part. Therefore, in the vehicles diagonal rearward which is not vehicles lateral part, the visual field range extrinsic is. But as shown in it can know if (c) of fig. 21 is looked at, if it has the view angle of camera with figure about 130, the viewing direction which is sufficient in the recognizing backward direction is obtained. It Han NunE can know the front state of not only the self-car neighboring but also the backward direction. Therefore, the composite picture which it produces by using the camera of this kind of 1 part is enough pragmatic in the moving back in the row parking or the column parking. Moreover, by using the fisheye lens the wide visual field range can be enough obtained from the camera of 1 part.

Here, in (c) of (c) of fig. 20 and fig. 21, in order to make easy to know the self-car location about the composite picture, the illust of self-car attaches. And it is accurately conformed the size of illust about the composite picture. In that way it is of course that operation becomes more easy.

(the fourth preferred embodiment)

The fourth subject which the fourth preferred embodiment describes in detail is provided to operator the composite picture which is one form of the invention which is comprised of order to solve, and in which object

except the road is not destroyed as to the virtual visual point image which changes the camera image and which cuts out and synthesized.

Next, it illustrates by using the drawing about the example of the display screen form.

It parallelly enumerates the first virtual visual point image, using of the vehicles lateral part only cameras (cameras (2, 6)) for behind of the image about this embodiment and the second virtual visual point image using only pair cameras (cameras (3, 7)) of behind and (a) of fig. 11 shows the old times indicated in screen, it uses one side camera and these virtual visual point images the other side camera is the virtual visual point image which does not use and prepared about camera (the camera (2) and camera (3) or the camera (6) and camera (7)) in which the respective field of view is overlapped. The overlap portion with the other side camera and non-redundant part is altogether included about the field of view of one side camera used in the preparation as to each virtual visual point image. Therefore, in the virtual visual point image of (b) of fig. 17, in the virtual visual point image which side of 2, the bar (P1) set after the self-car right rearward ceasing to exist nots and shows the annihilation pig. Of course, arrange and display in screen. A plurality of virtual visual point images is shown in the separate screen and screen is changed.

Generally, when 2 kinds condition as follows was altogether satisfied, the phenomenon that this kind of road extrinsic object ceases to exist occurs.

Condition 1: the direction in which each camera in which it became the origin of the subimage comprising boundary of 2 took a photograph of the foot orthosis was different. If as to this, the direction seeing object was changed from the camera of 2, when each camera image was changed to the virtual visual point image, this, means that the direction in which object is distorted is different. In this is the bar (P1) deformation of (a) of fig. 17, it authentically can know.

Condition 2: the foot orthosis is in the boundary neighborhood of subimage. When as to this, the object distorted by the deformation is in the boundary neighborhood, this, means that the part which is distorted as the shredding process for preparing subimage and hangs down is nearly erased. This can know at the bar (P1) deformation of (a) of fig. 17.

Therefore, there is no things in which object is struck out as long as the condition 1 is not satisfied. (a) of fig. 12 is the conceptual diagram which indicates the old times which object does not erase even when satisfying the condition 2. In (a) of fig. 12, bar stands at the pair camera of the back of vehicle, immediately, the immediately after. However, since nots satisfying the condition 1, that is, the camera (3) the camera (7) faces nearly, the same direction about bar. Therefore, even if a camera image is transformed, bar is distorted to screen below increase due to the likeness. Therefore, in boundary, processing etc. are performed. In that way mixes the subimage of the camera (3) and subimage of the camera (7) it prevents from bar being destroyed.

Similarly, object is not nearly destroyed if the condition 2 is not satisfied. (b) of fig. 12 is the conceptual diagram which indicates the old times which object does not erase even when satisfying the condition 1. In (b) of fig. 12, bar rearwards a little fell with the vehicles right diagonal and it was west. The condition 1 is satisfied since being in the visual field range of cameras (2, 3) of 2 part positioned in the other place. But the bar which does not satisfy the condition 2, and therefore, it falls down from that is, the subimage of the camera (2) and subimage boundary of the camera (3), and therefore, is distorted in the subimage of the camera (3) as if it increases from bottom to the screen right side is not destroyed by fire to boundary at least, it shows.

Therefore, it is one needle in case of designing the screen configuration inside. In order that the condition 1 is avoided, the point which does not prepare for the boundary of the subimage prepared of one screen to the camera image of the other 2 can be given. The above-described drawing shows the certain one example. It divides into the screen of 2 in order not to prepare the boundary of the boundary of the camera (2) and camera (3) and camera (6) and camera (7) in the same screen.

And in case 8 the camera image like fig. 2 is used, image can be comprised of 2 screen like indicating in the example of (b) of fig. 11 (the Figures are omitted the synthetic origin oneself photographed images). In (b) of fig. 11, it parallelly enumerates and the composite picture, using only the camera of both sides and the composite picture using only the camera of the either before or after are indicated in screen as to the virtual visual point image. It is prepared based on any kind of case, or the needle. If it is the case, of course, it has no relation in this example through the screen configuration except the thing shown.

(the fifth preferred embodiment)

The fifth preferred embodiment is one form of the invention which is comprised of order to solve the above-described fifth subject. Image is discontinuous in the boundary of the subimage which is adjacent as to the virtual visual point image. In order that it prevents to be indistinct, therefore bring difficulty in operation, the separate image imprinting the part which is unsequel is inserted in the virtual visual point image and it puts and it presents operator.

Next, it illustrates by using the drawing about the example of the display screen form.

(a) of fig. 13 is the drawing showing the screen type which it produces by using 4 the camera of cameras (2, 3, 6, 7) shown for fig. 2. Globally, the virtual visual point image which it synthesizes by using 4 the camera image looked down from the upper part is used. And subwindow is set up and right and left reverse image of the camera (6) having right and left reverse image of the camera (2) experiencing to the half right of the image top and takes a picture of the right rear of the vehicles in the half left of the image top and takes a picture of the left rear of the vehicles are indicated. As to the virtual visual point image, about access with the parking car generals, it cannot grasp in the oval part surrounded by the dotted line. But in right and left reverse image of the camera (2) indicated by subwindow, the naked portion surrounded by the solid line about access of the parking car can be Han NunE grasped as bomb.

And (b) of fig. 13 is the drawing showing the other screen type which it produces by using 4 the camera of cameras (2, 3, 6, 7) shown for fig. 2 (the synthetic origin oneself photographed images is the Figures are omitted). Globally, the virtual visual point image which rearwards looks down from the upper part with diagonal and which it synthesizes by using the image of cameras (3, 7) and which inverts right and left is used. And the reverse image of the camera (2) is set to the right of the image bottom half and subwindow is set up and the reverse image of the camera (6) is indicated in the left of the image bottom half. In the example of (b) of fig. 13, it is brought up for discussion that the gazing point of the virtual visual point image comes for the top half of the entire screen. Therefore, subwindow is arranged to the right and left of the screen bottom half. Effect is the same with (a) of fig. 13.

It fixedly arranges subwindow in the part which does not bring difficulty in operation even if it hides among the virtual visual point image as the background image as to every the examples. And it has no relation even if the arrangement place is appropriately moved according to the ambient condition etc.

The detail of about access with the surrounding area of vehicle object can be grasped without the movement of the eye line by looking upon the mirror phase displayed on the subwindow about the part, which does, and in that way the position relation of the ambient water and self-car is able to grasp with the virtual visual point image, and simultaneously, consists in boundary to discontinuity with this kind of screen configuration.

(the sixth preferred embodiment)

The sixth preferred embodiment is one form of the invention which is comprised of order to solve the above-described sixth subject. It takes preference about the lateral area of the self-car which is the place which wants to grasp the detailed situation in the complicated driving operation in the other part and it presents operator.

As to the column parking which (a) of fig. 14, and (b) is one of the complicated driving operation, it is the composite picture of the parking action halfway and parking action initiation the respective drawing showing. In a virtual visual point image, the camera set up in the side of vehicles is taken preference of and it uses. In that way the problem of being discontinued since the vehicles (P CAR) among park is reproduced to camera (4 and 5) in image is revealed.

Of course, if the arrangement of subimage is arranged to this kind of form, discontinuous the part is possible to give the sense of incongruity to user in the part since focusing on forward and backward of car. But as shown in it describes about advantage in for example, the third preferred embodiment, the sense of incongruity of discontinuous the part can be relieved through the etc. which it arranges the necessary image in the virtual visual point image in order to perceive and indicates the front of the vehicle progress direction.

In the above-described example, the camera of the vehicles lateral part is taken preference of and it uses. In that way in order to become easy that the part gazed steadily looks in the column parking the boundary of the virtual visual point image is comprised. According to use or the driving condition, the boundary of this subimage changes. Therefore, it becomes possible to provide the easy image that it has to operator and operator looks.

Figure 15 is a drawing showing an example of the boundary switching of the subimage in the row parking. When parallel-park, the contact whether or not with the object (for example, the vehicles (P CAR S) among park etc) of the vehicles lateral part is decided on to the main part and the main part need to confirm from the start-up beginning ((a) of the drawing 15) to the halfway ((b) of the drawing 15). For this reason, firstly the camera set up in the side of vehicles is used. As long as it is possible, the photographed images of the side of vehicles camera the virtual visual point image which it widely uses is presented. In the meantime, in the final step in which about half of the vehicles already enters the parking space, the contact whether or not with the object (for example, the vehicles (P CAR B) among park etc) of the back of vehicle is decided on to the main part and the main part need to confirm. For this reason, firstly the camera installed at the vehicles rear part is used. As long as it is possible, the photographed images of the vehicles rear part camera the virtual visual point image which it widely uses is presented.

Here, in the mode giving priority to the camera of the side of vehicles, switching to the mode giving priority uses the check signal of the sensor which it installs in for example, the vehicles and which performs the rear object scanning the vehicles rear part camera as trigger. If sensor detects if that any kind of object exists in the back of vehicle, it has this as trigger and the camera of the vehicles rear part is switched to the display mode giving priority.

And as the switching trigger, it has no relation even if for example, anything including the handle operation or the gear manipulation etc. is instead of used with object detecting sensor. Moreover, of course, it has no relation even if operator passively changes the display mode.

Figure 16 is a block diagram showing the system configuration enabling the switching of the above-described display mode. In the configuration of fig. 16, the mapping table selecting unit (25) receives the screen mode switch signal (for example, the traffic signal of the object detecting sensor). The mapping table (MPT) is switched according to the signal content. For example, in order that the auto-switching as described above is realized, the camera of the side of vehicles the mapping table of the mapping table of the display mode giving priority and the display mode giving priority to the camera of the vehicles rear part is prepared for against in advance.

The display type of the composite picture for realizing the object of or more the invention was illustrated. Here, even if the suitable mapping table is prepared for in the device configuration for realizing this composite picture in the amount of the image indicated, it is good. And it has no relation even if the mapping table is automatically prepared according to situation.

And the vehicles as to the invention comprises the normal vehicle, the small-sized car, lorry, the autobus etc. And the technical spirit of the present invention can be applied to. If it is the case, the special car including crane, excavator etc. can be done by the vehicles of the present invention.

Here, in the description described in the above, with being applied to the vehicles however similarly the monitor system about the invention the moving body except vehicles, for example, airplane or the ship etc. can apply. And camera is set up in the monitoring object except the moving body, for example, the monitoring object except the moving body, for example, store, residence, the display booth etc.

And the installation position or the algebra of the plurality camera is not restricted to show. For example, it has no relation even if each pair camera is arranged to four corner of the vehicles.

And even if the function of the image processor about the invention realizes a part by using the special-purpose hardware, it all has no relation in other words. And it has no relation even if it realizes with the software. Moreover, it is possible to use the recording medium or the transmission media storing the program for executing the whole function of the image processor about the invention or the part to computer. For example, in the configuration making use for computer, even if each treatment means including the image composition area etc. is realized with the software performed to CPU and it stores in ROM or RAM, it has no relation.

According to the invention like the or more, the image looking around right and left 180 drawing viewing direction of the back of vehicle makes a reverse turn and the image is indicated. Therefore, user authentically can capture the object existing in this visual field range with the indicated image. Therefore, as shown in Figure 4, the driving operation is executable from abeam only by looking at image in case of the etc. entering into into the road without the others' help while going back.

And it experiences according to the invention and relatively vehicles, at least, the ground of 1 tire is expanded. Since the image which is reduced according to become distant from the vehicles is indicated, it at the same time is confirmable with the detailed situation of the vehicles close staff direct and front state of the progressive direction by user on equalizing. Therefore, when going ahead as about access to the roadside of self-car or going back, the front state of the progressive direction can be known in the access including roadside etc. It brushes past with the corresponding vehicle at the narrow road driving only by looking at image although it is the operator who is not good at operation. It very makes the approach light simple.

And according to the invention, because it is arranged and marked while the video of the traveling direction of the vehicles or the mobile direction maintains the position relation with the virtual visual point image, at the same time, it not only the situation of the surrounding area of vehicle but also the progress direction front state when going ahead or going back is confirmable from user on equalizing. Therefore, in the park of the etc. accompanying the handle rotation, it one by one is no need to confirm with visual or mirror and the progressive direction state is focused on operation in case of the advance / moving back.

Moreover, according to the invention, the camera image of one side is not deleted from the overlap portion of the field of view and it is used as to each virtual visual point image. Therefore, there is no work in which the object existing in the overlap portion is destroyed on the virtual visual point image. Therefore, it becomes possible to provide the image including the necessary information to operator to the safe driving. Operator can become relieved and the ambient condition can be confirmed operator as the Chinese merchant.

And according to the invention, the camera image which is the same looked in the door mirror of right and left is indicated with the virtual visual point image. Therefore, general to the virtual visual point image with self-car and ambient water, user altogether can confirm distance with the vehicles lateral part object of the driver's seat rearward and self-car the position relation as the door mirror image at one screen. Therefore, operator can know the ambient condition only by looking at screen even if it is the door mirror confirmation or the eye confirmation not issued. Therefore, operator becomes relieved to screen and operator focuses on operation.

Moreover, according to the invention, the image taken a picture with the camera set up in the side of vehicles is used of a mode the production of the virtual visual point image. Therefore, in many part of the driving condition which need the complicated driving operation, it becomes possible as to the lateral area of the vehicles which is the place which specifically operator wants to know to provide the less without discontinuous the part image to operator.



Scope of Claims

Claim 1 :

The field of view of the back of vehicle it is installed in the vehicles comprising: the image processor which it has the photographed images of the camera of 1 part including the viewing direction of right and left 180 drawing and camera as input; and it produces the image looked from the inputted camera image in the virtual viewpoint and it indicates in the display device, wherein the image processor has the mode inverting the image including right and left 180 drawing viewing direction of the back of vehicle and indicates.

Claim 2 :

The monitor system, wherein the image processor one camera taking a picture of the surrounding area of vehicle, and the image processor are included it has the mode experiencing and indicates the composite picture which is synthesized relatively so that enlargement and reduction ratio of the vehicles close staff part including one tire ground at least of the vehicles be enlarged than enlargement and reduction ratio of the vehicle periphery part, and the image processor has the photographed images of camera as input; and it produces the composite picture to this camera image and it indicates in the display device.

Claim 3 :

The monitor system, wherein the composite picture as to claim 2 in the vehicles close staff part, enlargement and reduction ratio become smaller as it becomes estranged to the vehicle periphery part.

Claim 4 :

The monitor system which the image processor is characterized as to claim 2 to produce the composite picture so that the part experiencing and follows the side of the vehicles have linearity.

Claim 5 :

The monitor system camera, at least, 1 is installed as to claim 2 in order to include a part of one side of car body and part of the front tire in the field of view at least, and in which the image processor uses one camera tomographing image at least, and which is characterized to produce the composite picture in order to include one side of car body and front tire.

Claim 6 :

The image processor, is the monitor system which is characterized to produce the composite picture in order to include tire by using one camera tomographing image at least camera, at least, 1 is installed it includes a part of the vehicle tire in the field of view it experiences at least one camera taking a picture of the surrounding area of vehicle, and the image processor are included. The image processor has the photographed images of camera as input, and which produces the composite picture from this camera image and indicated in display device.

Claim 7 :

The monitor system, wherein the image processor the camera of 1 part taking a picture of the surrounding area of vehicle, and the image processor are included it has the mode which arranges the image of the traveling direction of the vehicles or the migrateable direction with the virtual visual point image while maintaining the position relation with the virtual visual point image and indicates, and the image processor has the photographed images of camera as input; and it produces the image looked from this camera image in the virtual viewpoint and it indicates in the display device.

Claim 8 :

The monitor system, wherein a plurality of cameras a plurality of cameras taking a picture of the surrounding area of vehicle, and the image processor is included the first and the second camera in which the field of view is overlapped are included; the image processor uses the first camera and it does not use and it prepares and, the second camera; the overlap portion with the second camera of the field of view of the first camera and the first virtual visual point image, including the non-redundant part and the second camera are used and it does not use and it prepares and, the first camera; and it is generable, it is the overlap portion with the first camera at the field of view of the second camera and the second virtual visual point image including the non-redundant part comprised, and the image processor has the photographed images of each camera as input; and it produces the image looked from these camera images in the virtual viewpoint and it indicates in the display device.

Claim 9 :

The monitor system, wherein the image processor as to claim 8 it has the mode arranging the first and the second virtual visual point image in the same screen and indicates.

Claim 10 :

The monitor system, wherein the first virtual visual point image as to claim 8 it is the virtual visual point image using with the camera installed at the vehicles lateral part only the image photographed by camera installed at the second virtual visual point image, is forward and backward of car it is the virtual visual point image using only the photographed image.

Claim 11 :

The monitor system, wherein a plurality of cameras taking a picture of the surrounding area of vehicle, and the image processor is included it has the mode indicating at least a part of the image which experiences and it includes the first camera taking a picture of the left back out part of the vehicles, and the second camera taking a picture of the right rear of the vehicles; and the image processor is inverted from right and left of the photographed images of the first camera or the second camera with the virtual visual point image, and the image processor has the photographed images of each camera as input; and it produces the image looked in the virtual viewpoint by using these camera images and it indicates in the display device.

Claim 12 :

The monitor system, wherein the image processor a plurality of cameras taking a picture of the surrounding area of vehicle, and the image processor is included as to the production of the virtual visual point image, it has the mode which takes preference of the image taken a picture with the camera set up in the side of vehicles and used, and the image processor has the photographed images of each camera as input; and it produces the image looked from these camera images in the virtual viewpoint and it indicates in the display device.



Drawings

Fig. 1

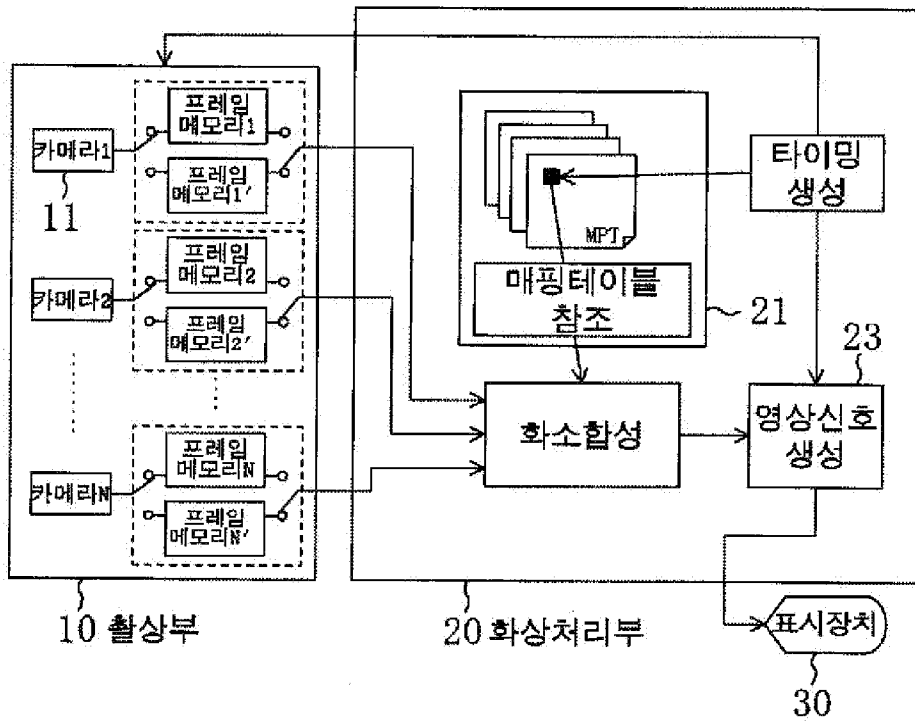


Fig. 2

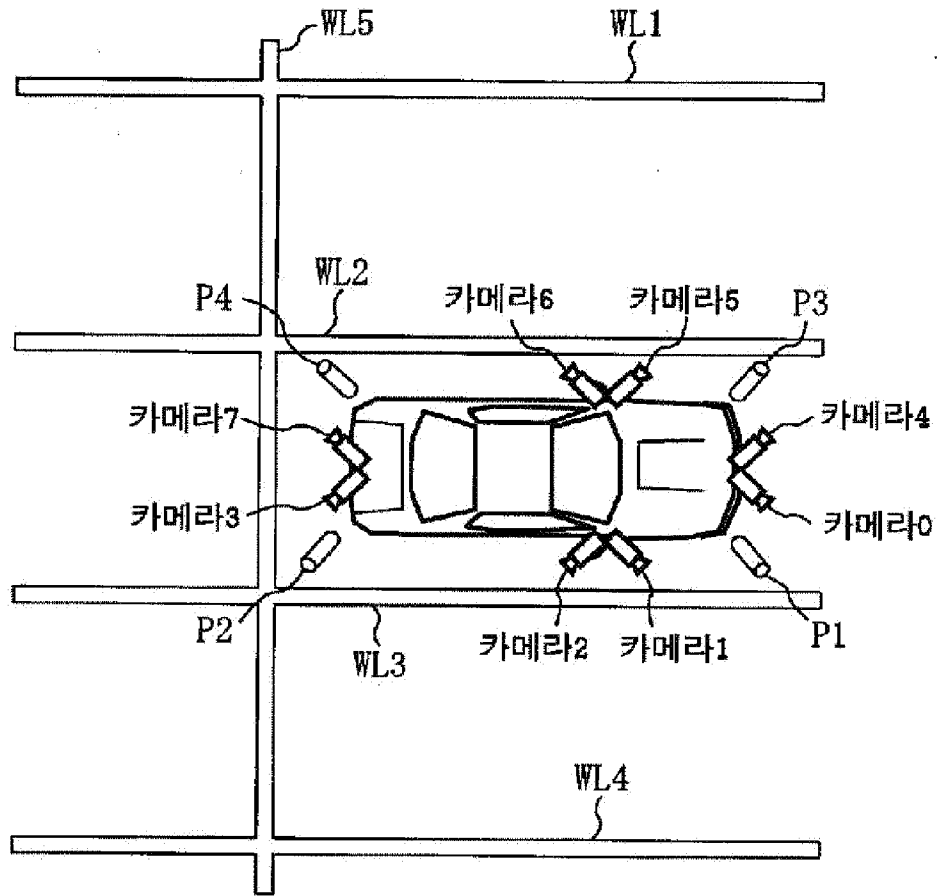


Fig. 3

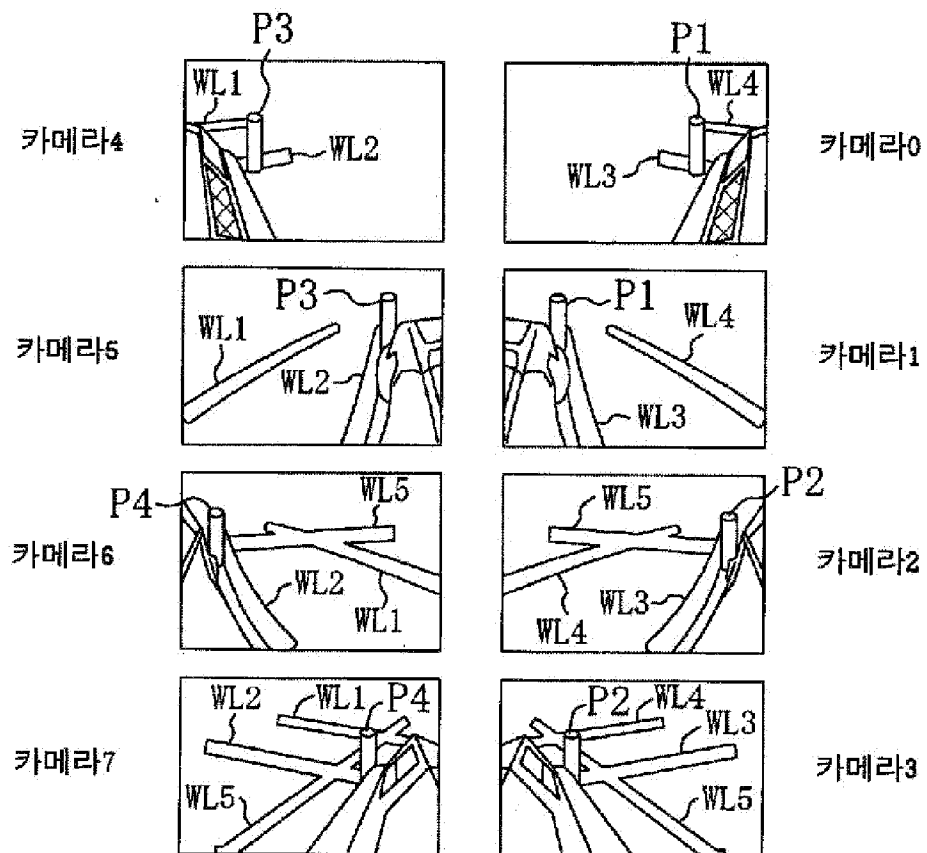


Fig. 4

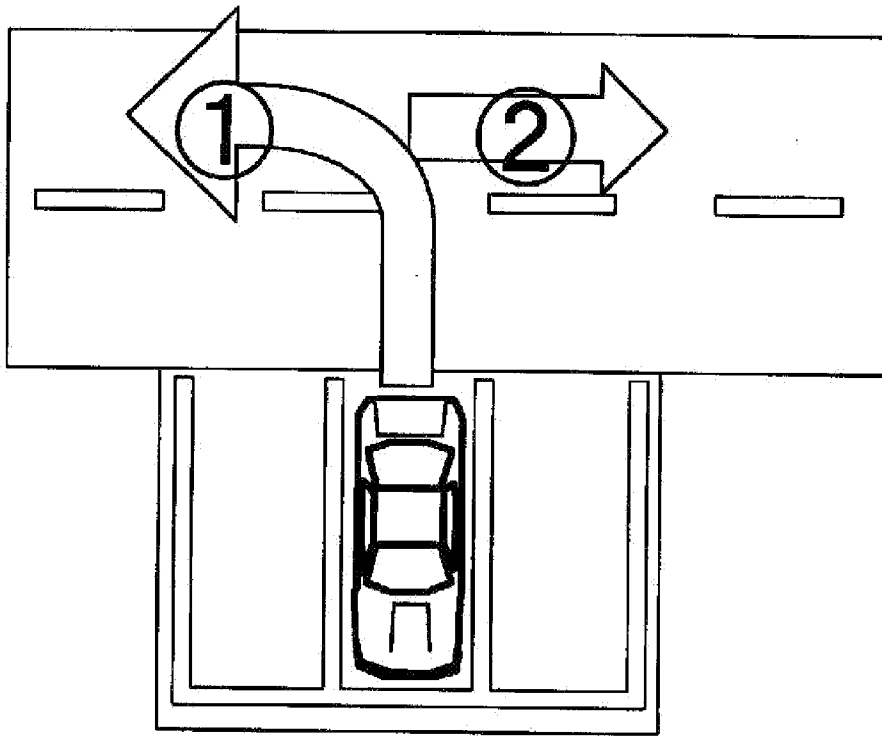


Fig. 5

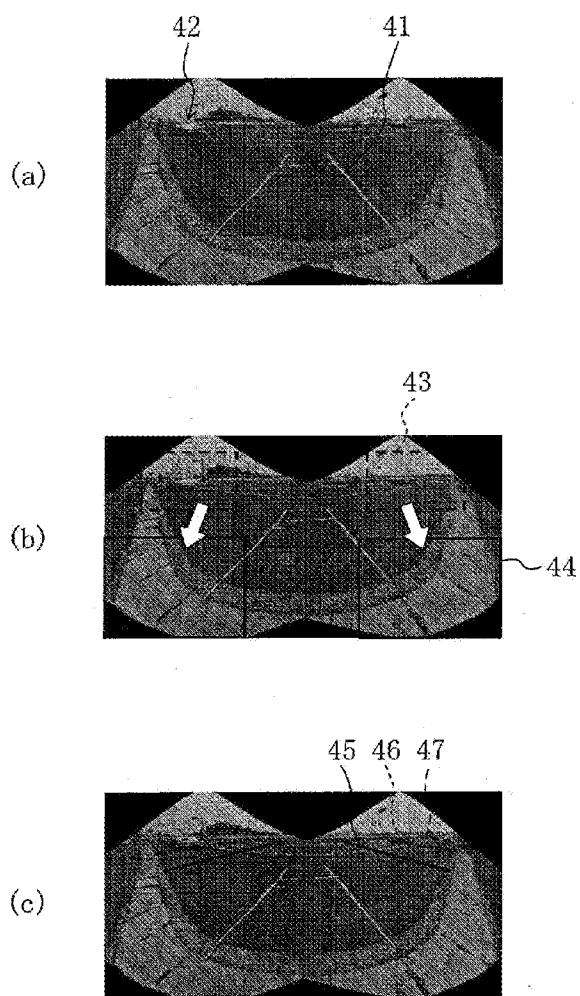


Fig. 6

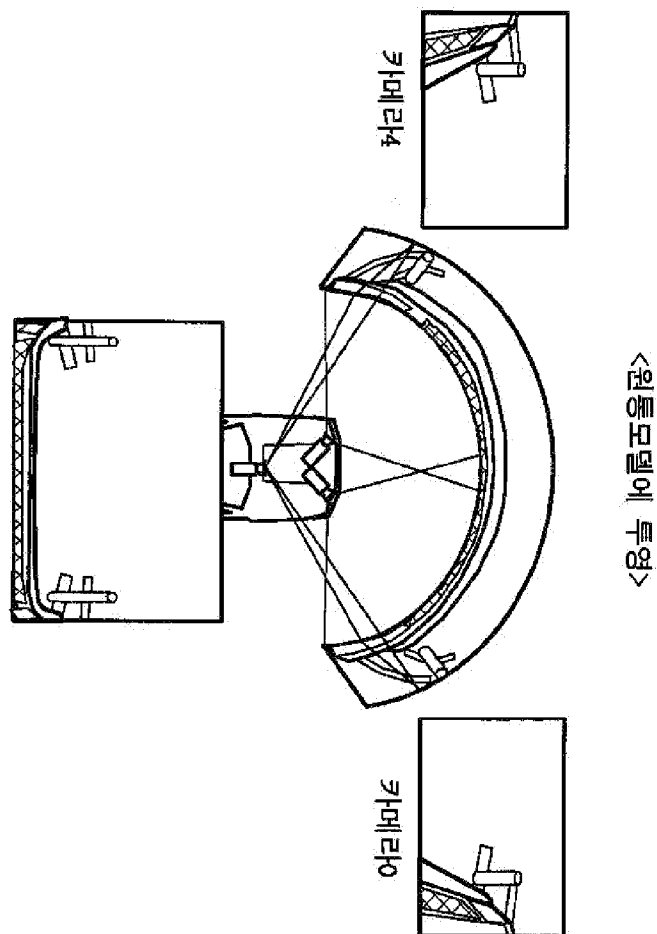


Fig. 7

<사발형모델에 투영>

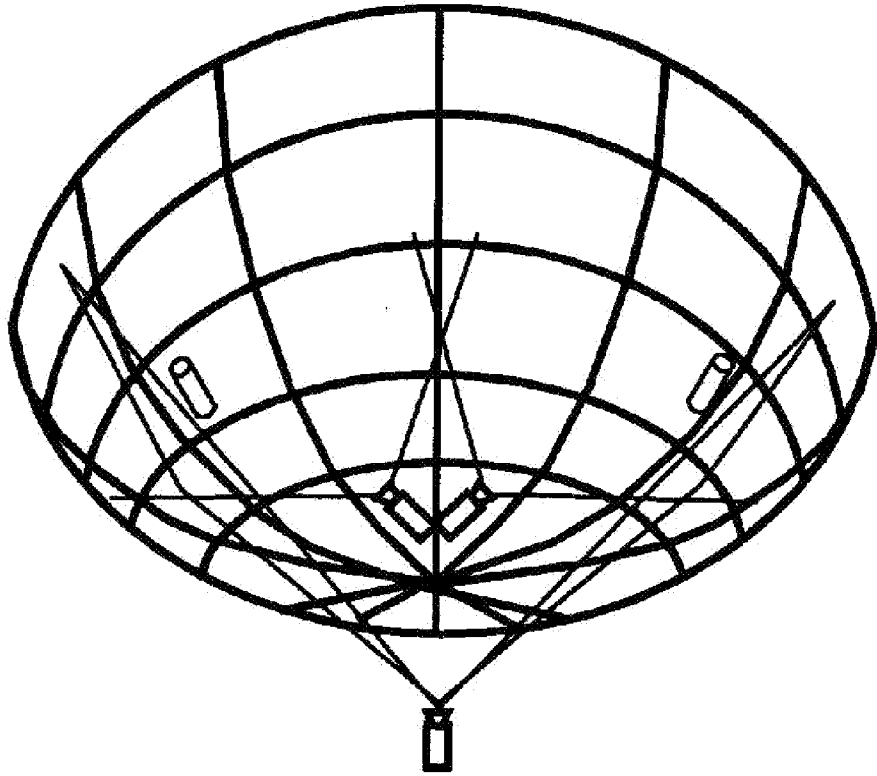


Fig. 8

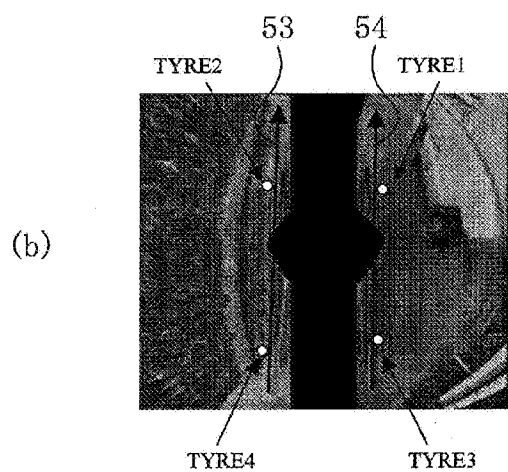
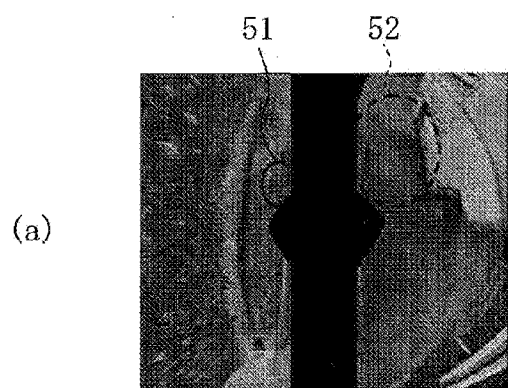
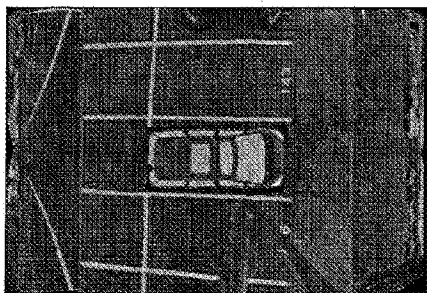
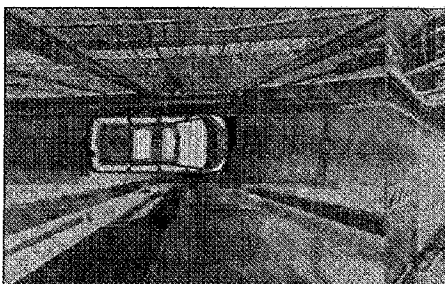


Fig. 9

(a)



(b)



(c)

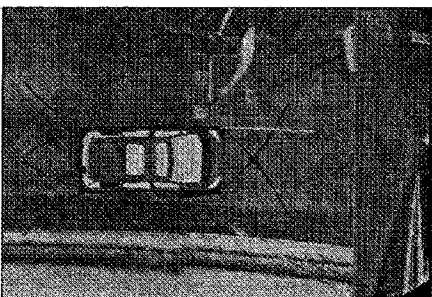
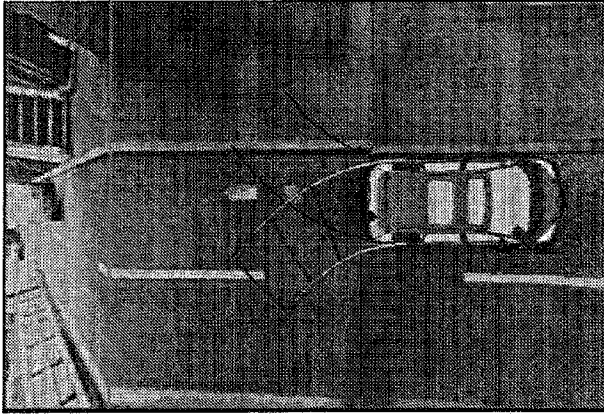


Fig. 10

(a)



(b)

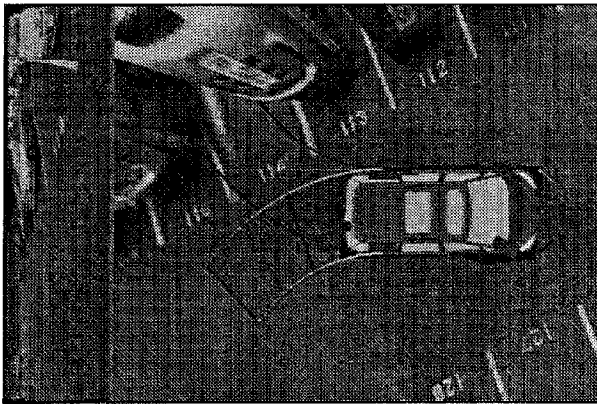


Fig. 11

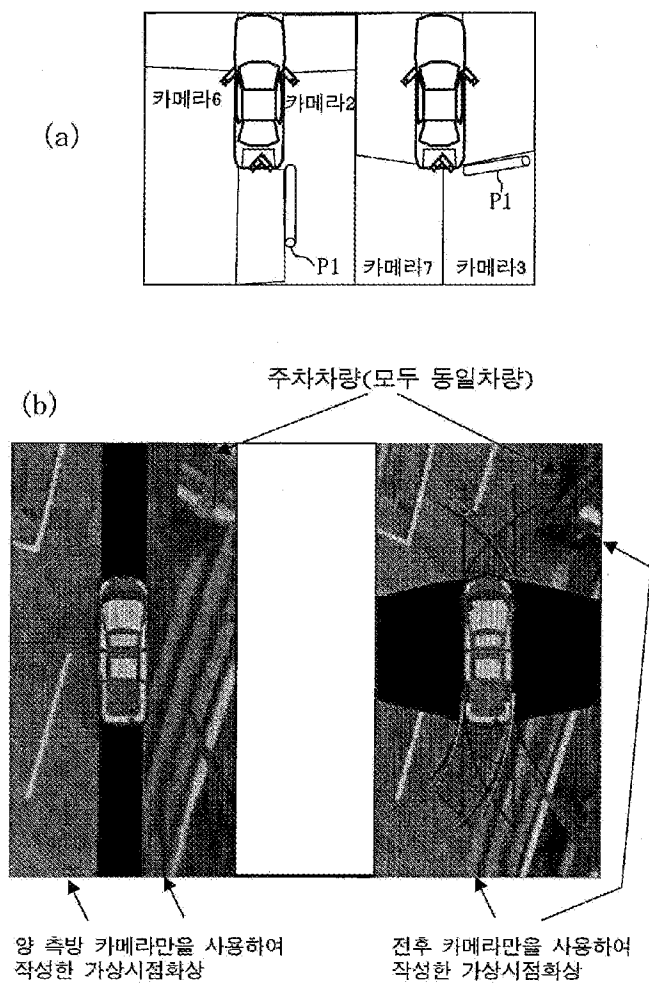


Fig. 12

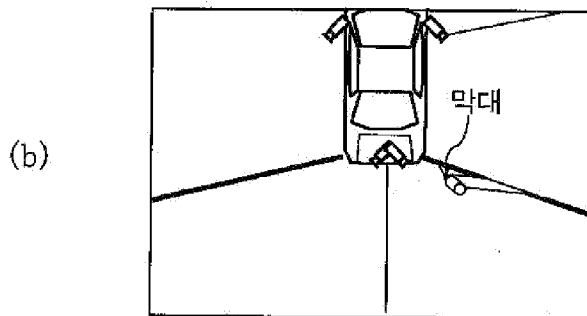
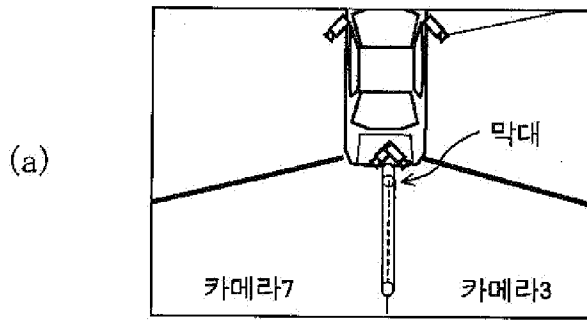


Fig. 13

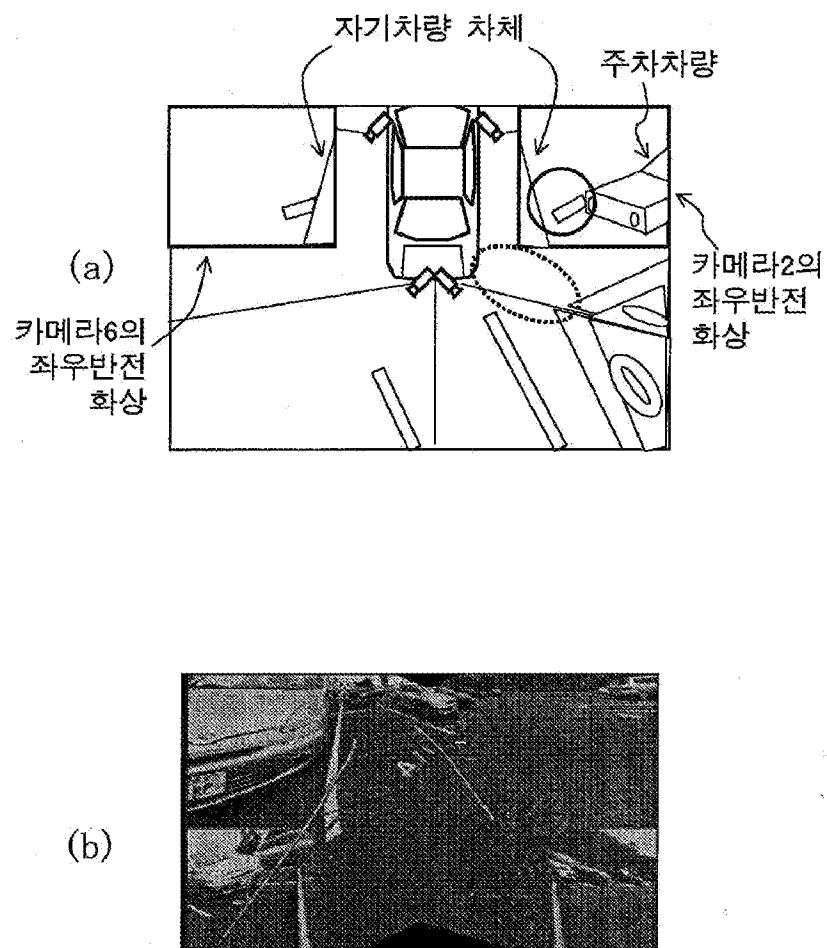


Fig. 14

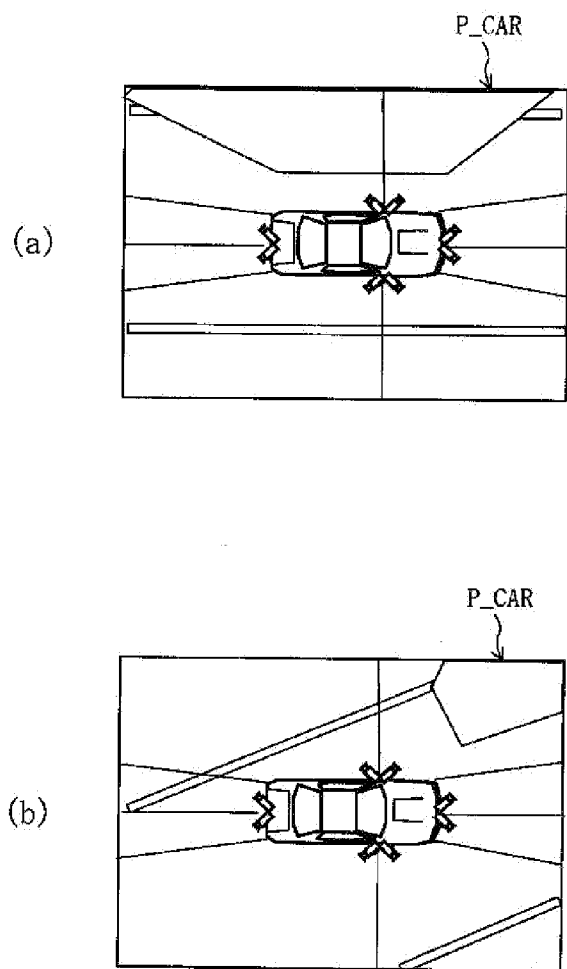


Fig. 15

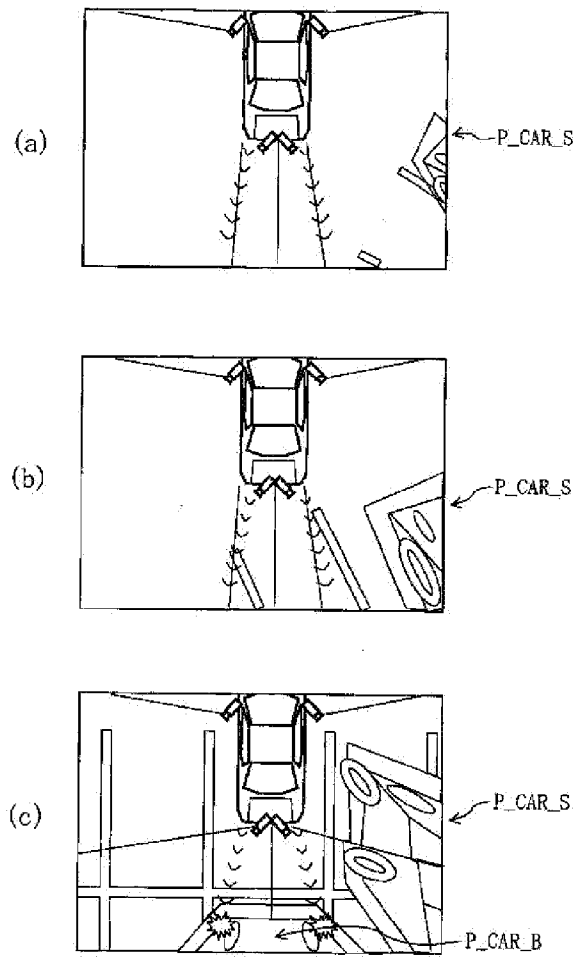


Fig. 16

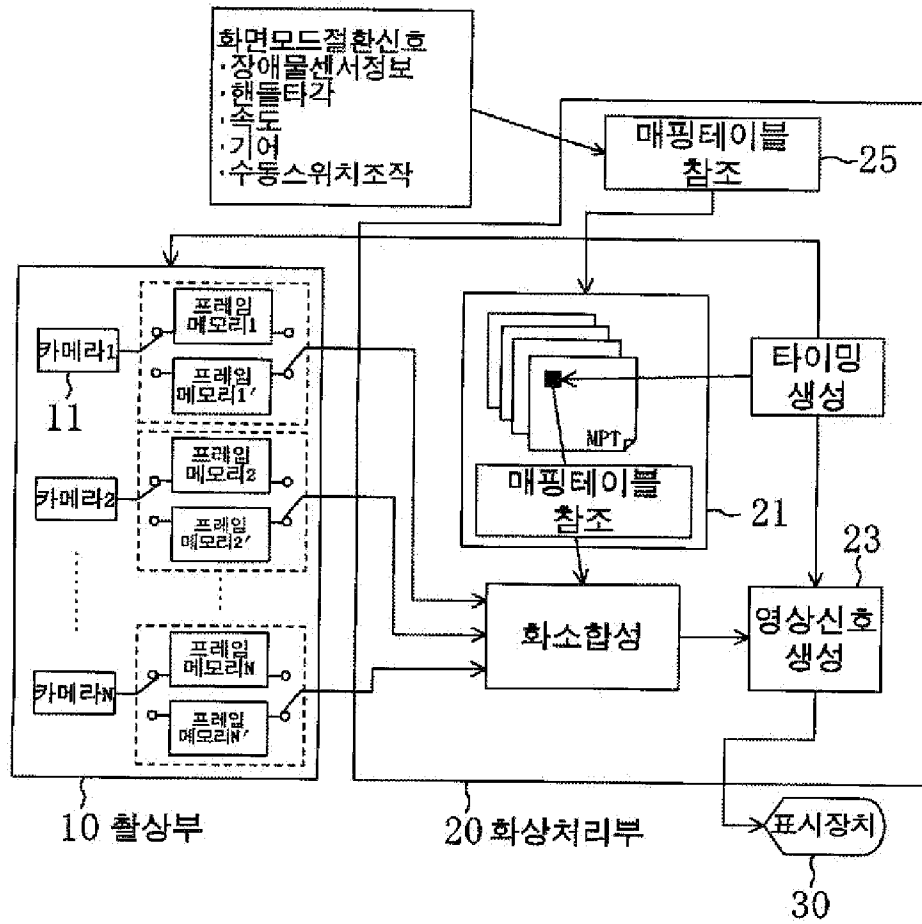


Fig. 17

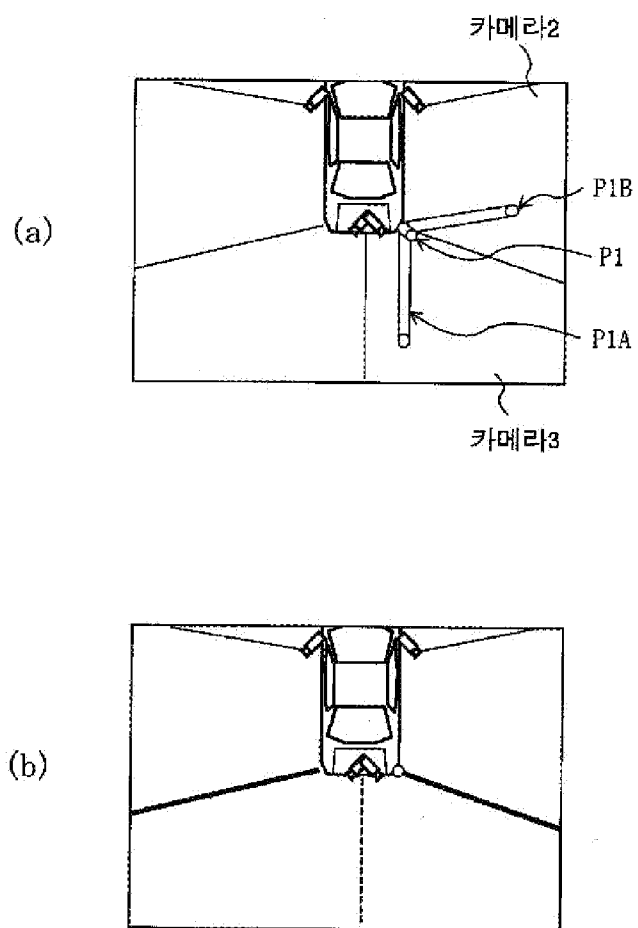


Fig. 18

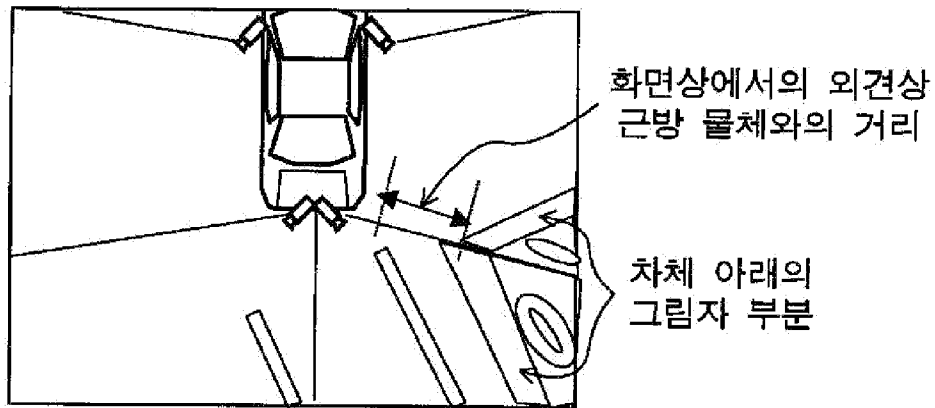


Fig. 19

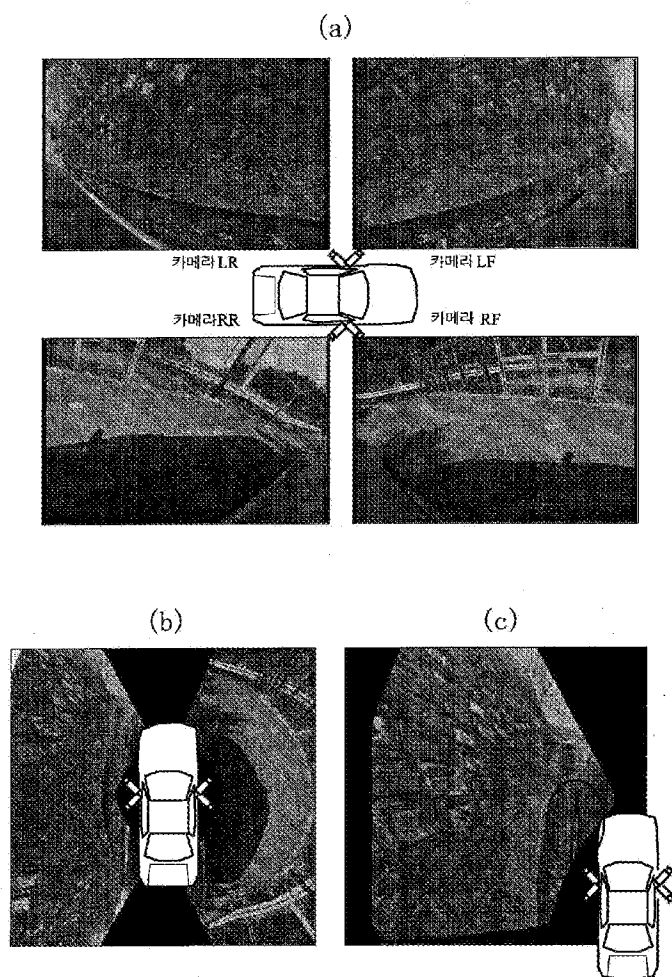


Fig. 20

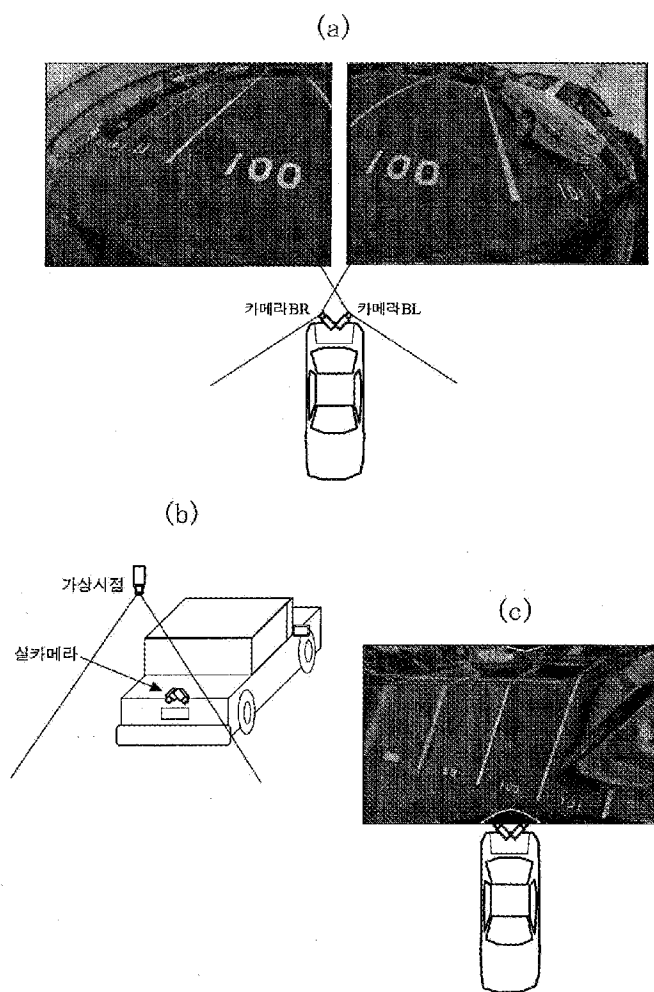


Fig. 21

